Gear Coatings for Loss of Lubrication Application

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Description:
OBJECTIVE: Develop and demonstrate gear coatings in order to increase the endurance of helicopter transmissions operating after loss of primary oil flow. The objective is to develop low cost, low friction, highly reliable coating that is capable of allowing a transmission to run for 45 minutes in a loss of lubrication condition. DESCRIPTION: Under normal rotorcraft operations, flowing lubricant keeps heat generation low and removes excess heat away from the gearboxes. In an oil-out condition, where the primary oil flow no longer exists, the rotating gear components generate more heat which leads to gearbox failure. Recent transmission oil loss incidents have caused emergency landings as well as fatalities. Army rotorcraft have specific loss of lubrication requirements for drive systems, as noted in ADS-50-PRF. The drive systems are required to operate after loss of primary oil flow for a minimum of 30 minutes at cruise conditions (approximately 50% power rating). The Army desires the ability to run for a longer period of time after a loss of lubrication condition to improve aircraft survivability. One way to meet and exceed this requirement is to employ the use of an emergency oil system. This auxiliary system takes over during the loss of primary oil flow, but requires the aircraft to always carry around the additional associated weight. This additional weight reduces aircraft payload and range. This topics goal is to develop a technology that will allow a gearbox to survive for at least 45 minutes at a 50% power rating, without the need for an auxiliary lubrication system. In order to meet this goal, an innovative gear coating approach is desired that will allow the gears to run at elevated temperatures for a longer period of time before failure. The gear coating technology developed under this effort should be designed to be affordable, capable of application to typical aircraft gear steels (AISI 9310, X-53, etc.), and compatible with typical gear manufacturing processes. Candidate coatings must be extremely durable, as gears are expected to

operate without failure for many thousands of hours (order 109 cycles) in a lubricated gearbox. The coating should be designed so that it does not wear at temperatures below 400 degrees Fahrenheit, and will only degrade during oil out conditions. The coating should be between 1-40 micron"s thick, entirely cover each gear tooth, and not be detrimental to gear performance in any way. If the coating process results in increased surface roughness, a method to restore the original surface topography should be addressed. PHASE I: Develop and conduct a feasibility demonstration of the proposed coating technology. This may include modeling of the coating performance, and coupon level experimental testing. This demonstration shall validate the solutions for identified critical technical challenges. PHASE II: Contractors are encouraged to collaborate with an Army rotorcraft OEM during Phase II. The contractor shall further develop the gear coating based on the Phase I effort for implementation on an Army rotorcraft. The capabilities of the advanced coating will be validated by performing a loss of lubrication test in a full scale rotorcraft gearbox. This testing shall validate the ability of the coating to increase loss of lubrication performance. PHASE III: This technology could be integrated in a broad range of military/civilian aircraft where loss of primary oil flow is a concern. The potential exists to integrate and transition this coating into existing and future Army gearboxes, such as those for the Apache, Chinook, Black Hawk, and Kiowa Warrior.